# Smart Gas Investment

As a bridge to a low-carbon future, natural gas can't – and shouldn't – meet every need.

By Dr. Carl Linvill

The low price and relative abundance of natural gas bring good news for both consumers and society. Consumers benefit from cheap gas. Society benefits from the availability of gas to help reach emissions reduction targets for 2030 and 2050. However, if we lean too much on gas in the near term, that low cost and abundant supply could encourage ill-advised investments – investments that create stranded cost burdens and delay progress toward a least-cost and least-risk low-carbon future.

Some describe natural gas generation as the "Swiss army knife" of technologies, as it can meet a variety of electric system needs. Yet while a Swiss army knife can prove handy, we don't often use it when we have access to a well-equipped toolbox. And that's the case here. Gas-fired generation may be functional for a number of uses, but it is not optimal for each one if we equip the electric system toolbox with least-cost, least-risk tools. Indiscriminate use of gas generation is not smart. It can introduce unnecessary costs and unacceptable risks.

Advocates supporting a large commitment to gas suggest that we'll need more than $500 billion worth of gas-fired generation and midstream gas infrastructure by 2035.[1] This aggressive level of expansion, as a shortcut to meeting near-term greenhouse gas reduction goals, in effect amounts to building a fleet of Swiss army knives: a gas fleet capable of providing a range of services, but not as effective as a toolbox full of optimized clean energy resources and operational practices. Furthermore, gas generation and infrastructure additions make for large, "lumpy" investments. They have technically useful lives of 30 to 50 years, but they may not be needed that long. A gas-heavy approach to decarbonization crowds out investment in renewable energy, energy efficiency, demand response, and storage resources, delays the transition to smarter systems operations practices, introduces the risk of stranded costs and makes the transition to a low-carbon power sector far more expensive and risky than necessary.

1. Energy Information Administration's (EIA) 2014 Annual Energy Outlook projects 255 GW, 323 GW, and 482 GW of new gas generation by 2040 its reference, high gas and oil resource, and high economic growth cases, respectively (http://www.eia.gov/todayinenergy/detail.cfm?id=17131#). EIA's reference case overnight cost for gas combined cycles is $917 million per GW (http://www.eia.gov/forecasts/capitalcost/pdf/updated_capcost.pdf), so these gas generation projections indicate an expense of $234 billion to $442 Billion by 2040. Interstate Natural Gas Association of America (INGAA) estimates $313 billion in mid-stream gas infrastructure by 2035 in North America (http://www.ingaa.org/Foundation/Foundation-Reports/2035Report.aspx). Midstream infrastructure costs, such as pipeline capacity and storage, plus gas generation costs in these gas heavy futures will constitute an expenditure well in excess of $500 billion by 2035.

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**Natural gas should complement other resources – not eclipse them.**

Achieving a decarbonized power sector that is both cost-effective and risk-managed requires a well-equipped toolbox. To that end, we need a "smart gas" approach – one that maximizes the use of low-cost, low-risk resources and practices. We want our gas-fired fleet to complement our other low-carbon resources – not eclipse them.

## Pathways to Decarbonization

A risk-aware approach to natural gas infrastructure optimizes the contributions of gas relative to long-term costs and risks, and considers the costs and risks of all complementary resources, to ensure that we don't lock in costly investment in unnecessary gas infrastructure. That is especially important now because decisions made over the next few years will affect how we generate and use electricity for decades, which in turn will affect the cost of electricity, the reliability and resiliency of the power sector, the global competitiveness of the U.S. economy, and our ability to reach greenhouse gas reduction goals over the next three-plus decades.

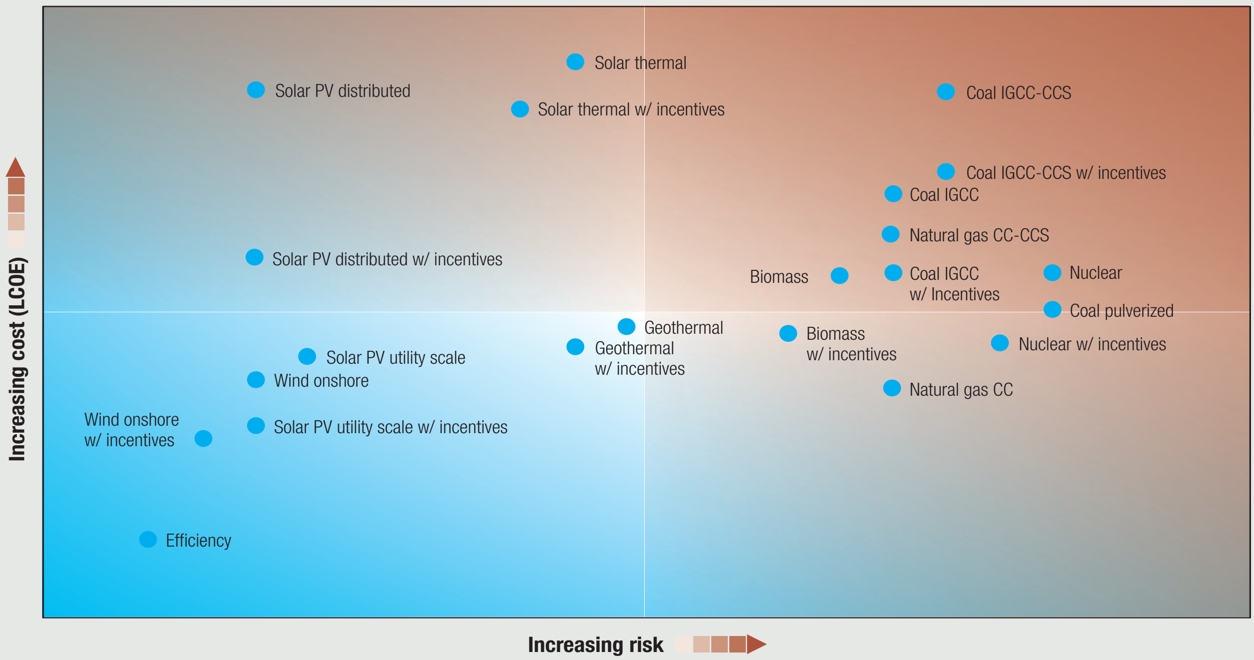
Let's begin by considering the very different relative costs and risks that accompany various different types of energy resources. *Figure 1* illustrates the levelized, unsubsidized costs and risks of new generation resources, and *Figure 2* contains a complete set of subjective risk rankings by technology type, including initial cost, fuel cost, future regulation, carbon price, and planning risks.[2] This risk-aware framework provides a useful basis for evaluating competing pathways to decarbonization and assessing the risk of overcommitting to gas.

Expert recommendations for decarbonizing the power sector

2. Binz, R., Mullen, D., Sedano, R., and Furey, D. (2014). Practicing Risk-Aware Electricity Regulation: 2014 Update. Boston, MA: Ceres. Available at http://www.ceres.org/resources/reports/practicing-risk-aware-electricity-regulation-2014-update/view.

**FIG. 1** **GENERATION TYPES: RELATIVE RISK & COST**

Smart Gas Should Recognize the Risks and Costs of Complementary Resources*




* Binz, R., Mullen, D., Sedano, R., and Furey, D. (2014). Practicing Risk-Aware Electricity Regulation: 2014 Update. Boston, MA: Ceres. Available at http://www.ceres.org/resources/reports/practicing-risk-aware-electricity-regulation-2014-update/view.

tend to fall along three pathways.[3] Each pathway includes an important but different role for gas.

Some foresee a "microgrid" pathway that emphasizes quick progress toward clean, distributed generation resources, energy efficiency, and storage, cost-effectively serving local needs while the regional electricity grid becomes much less important. In this future, gas-fueled combined heat and power (CHP) generation and fuel cells resources are part of the distributed generation fleet and serve collections of microgrids by providing energy and ancillary services.

Others suggest a "large-scale renewable energy" pathway, in which grid-scale wind and solar provide most of our energy needs. A flexible, efficient gas fleet is required to complement these resources.

Still others foresee a "back to baseload" pathway, where baseload gas plays a much larger role. In this future, nuclear power also returns as a primary baseload resource and carbon capture and sequestration (CCS) technologies prove viable and cost-effective, enabling continued use of fossil generation as a primary generation resource. Variable energy resources (VERs) figure less prominently in this future than in the first two pathways, but significant investment in VERs is still required to meet carbon reduction goals cost-effectively.

**Ideas for decarbonizing tend to follow one of three pathways – microgrids, utility-scale renewables, or a gas/nuclear baseload scheme.**

The cost and risk rankings shown in *Figures 1 and 2* demonstrate that the "back to baseload" pathway relies on relatively high-risk and high-cost resources. Designing natural gas policies that bank on this third future is very risky because it is predicated upon dramatic declines in the cost of CCS, demonstration that sequestration is safe on a large scale, a reversal of the long-term cost trend for new nuclear power, and public acceptance of the risks of much higher electric prices, new nuclear power, and sequestration. Furthermore, this future requires concomitant

3. See for example, Lovins, A. and Rocky Mountain Institute. (2011). Reinventing Fire: Bold Business Solutions for the New Energy Era. White River Junction, VT: Chelsea Green Publishing. p. 232; National Renewable Energy Laboratory. (2012). Renewable Electricity Futures Study (NREL/TP-6A20-52409). Golden, CO: National Renewable Energy Laboratory, available at http://www.nrel.gov/analysis/re_futures/; Sustainable Development Solutions Network (SDSN) and Institute for Sustainable Development and International Relations (IDDRI). (2014). Pathways to Deep Decarbonization: Interim 2014 Report, available at http://unsdsn.org/wp-content/uploads/2014/07/DDPP_interim_2014_report.pdf; and Kristov, L. (2015). The Future History of Tomorrow's Energy Network. Public Utilities Fortnightly, 153 (5), 20-24.

**Fig. 2** **Identifying the Type of Risk**

A Risk Assessment of New Generation Resources*

| Resource | Initial cost risk | Fuel cost risk | New regulation risk | Carbon price risk | Water constraint risk | Capital shock risk | Planning risk |
|---|---|---|---|---|---|---|---|
| Biomass | Medium | Medium | Medium | Medium | High | Medium | Medium |
| Biomass w/ incentives | Medium | Medium | Medium | Medium | High | Low | Medium |
| Coal IGCC | High | Medium | Medium | Medium | High | Medium | Medium |
| Coal IGCC w/ incentives | High | Medium | Medium | Medium | High | Medium ↑ | Medium |
| Coal IGCC-CSS | High | Medium | Medium | Low | High | High | High |
| Coal IGCC-CSS w/ incentives | High | Medium | Medium | Low | High | Medium ↑ | High |
| Pulverized coal | Medium | Medium | Very Low | High | High | Medium | Medium |
| Efficiency | Low | None | Low | None | None | None ↓ | None |
| Geothermal | Medium | None | Medium | None | High | Medium | Medium |
| Geothermal w/ incentives | Medium | None | Medium | None | High | Low | Medium |
| Natural gas CC | Medium | High | Medium | High ↑ | Medium | Medium | Medium |
| Natural Gas CC-CCS | High | Medium | Medium | Low | High | High | Medium |
| Nuclear | High | Medium | High | None | High | High | High |
| Nuclear w/ incentives | High | Medium | High | None | High | High | High ↑ |
| Solar PV distributed | Low | None | Low | None | None | Low | Low |
| Solar distributed w/ incentives | Low | None | Low | None | None | Low | Low |
| Solar PV utility scale | Low | None | Low | None | None | Medium | Low |
| Solar PV utility scale w/ incentives | Low | None | Low | None | None | Low | Low |
| Solar thermal | Medium | None | Low | None | High | Medium | Medium |
| Solar thermal w/ incentives | Medium | None | Low | None | High | Low | Medium |
| Wind onshore | Low | None | Low | None | None | Low | Low |
| Wind onshore w/ incentives | Low | None | Low | None | None | None | Low |

* Binz, R., Mullen, D., Sedano, R., and Furey, D. (2014). Practicing Risk-Aware Electricity Regulation: 2014 Update. Boston, MA: Ceres. Available at http://www.ceres.org/resources/reports/practicing-risk-aware-electricity-regulation-2014-update/view.

investment in both baseload gas and renewable VERs. The "back to baseload" pathway thus introduces the risk of significant stranded costs.

Recent modeling work by the International Energy Agency (IEA) and others indicates that capacity utilization of baseload resources will decline as the presence of VERs grows (*Figure 3* illustrates this relationship).[4] Near-term commitment to new baseload gas generation and midstream infrastructure may look cost-effective with the current fleet in North America, but as VERs' share of the generation mix grows – as it must in any low-cost decarbonization future – this new baseload fleet becomes a serious stranded-cost financial risk for ratepayers and society.

By contrast, the resources relied upon in the "microgrid" and "large-scale renewables" pathways tend to be lower in cost and risk. Building a smart gas fleet with the flexible capabilities needed to support these pathways likewise is relatively low-risk, as it complements a wide variety of low-carbon resource futures and relies on relatively low-risk resources. In both the "microgrid" and "large-scale renewables" futures, gas generation and infrastructure investment will be optimized to complement zero-carbon resources at least-cost, least-carbon emissions, and low risk of stranded gas assets.

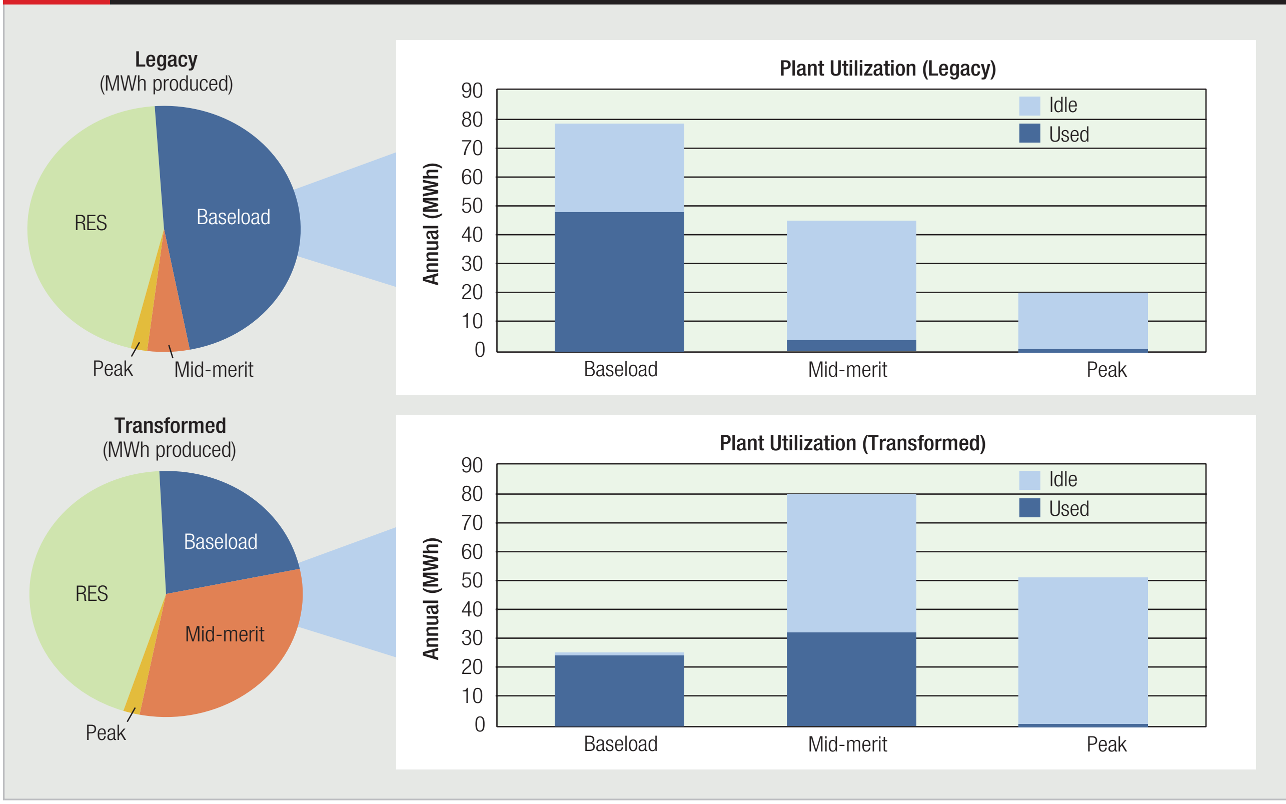
## A Five-Step Plan

Power sector policies have traditionally been designed to promote the building of large, centralized fossil-fueled resources, and have not fully considered all of the resources and practices available to meet system and societal goals. Where various low-carbon resources have been considered, their relative long-term risks and costs have typically not been.

By contrast, any policy for decarbonizing the power sector and building a complementary and optimized gas-fired fleet should take advantage of all low-carbon resources and smart

4. International Energy Agency (IEA). (2014, February). The Power of Transformation: Wind, Sun and the Economics of Flexible Power Systems. ISBN PRINT 978-92-64-20802-5. pp. 162-164. Available at https://www.iea.org/bookshop/465-The_Power_of_Transformation.

**FIG. 3** THERMAL PLANT USE – PRE- & POST-TRANSITION




operational practices that can be found in our toolbox. That will require that electric system needs are made transparent, so that the compensation provided through markets and tariffs is aligned with the value of meeting long-term system needs.

Getting the right gas generation and infrastructure built remains an important part of meeting system requirements at least cost and least risk, but the need for new gas facilities must be considered within the context of the full toolbox. Getting market rules, tariffs, and policies right is a value alignment problem that can be addressed in five steps.

- **Build an Intelligent Grid.**
- **Make Needs Transparent.**
- **Include all Resources.**
- **A Clean-First Dispatch.**
- **Improved Permitting.**

**Intelligent Grid.** More investment is required in state-of-the-art-information, communications, and electric system control technologies to identify system needs accurately and to communicate them clearly (through market and regulatory signals) to generators, consumers, and service providers.

Since 2010, the American Recovery and Reinvestment Act's (ARRA) grid modernization funds have been instrumental in expanding investment in devices ranging from the bulk electric system down to individual customers. As a result, phasor measurement units (which allow increased use of the existing transmission system) have increased tenfold, the number of deployed smart meters is projected to exceed 65 million by 2015, and the internet is making its way into electricity services markets. However, ongoing investment will be required for full, cost-effective participation by customer resources, including energy efficiency, demand response, storage, and distributed generation, and variable energy resources, including wind and solar in constructively shaping net demand and in providing system services.

**Too much reliance on gas can crowd out investment in other, more effective resources.**

State and federal policies must encourage continuing investment in grid modernization, the development of interoperability standards that facilitate seamless information transfer to and from the consumer and all along the network, and operational reforms to more effectively use the modernized grid.

**Transparent Needs.** Getting the right system technologies installed marks a necessary step toward transparency, but is not sufficient. Both organized markets and vertically integrated utilities struggle with information opacity. As VERs penetration increases, and as local needs increasingly are met by local resources, the value increases for those system components that are able to complement uncontrolled changes in VERs supply. These improved system capabilities allow increased participation by efficiency, demand response, and storage in meeting system needs. Improving transparency is paramount to ensuring that market opportunities are available for clean energy resources, flexibility options such as demand response and distributed storage, and the right kind of gas generation.

All markets and procurement processes (whether real-time, hour-ahead, day-ahead, or long-term) must ensure the transparency of "net electricity system needs." Known also as "net load," this term identifies the need for power resources after the effects of energy efficiency and non-dispatchable VERs production are first taken into account. This step allows those clean and flexible resources that can meet needs most cost-effectively – particularly demand-side options – to compete on an equal footing. Failure to do this leads to excessive reliance on less efficient and less flexible fossil generation and precludes the formation of an optimized gas fleet.

In states where a vertically integrated utility plans the electric system, resource planning and procurement must be reformed to require utilities to more transparently communicate system needs to customers, third-party aggregators, and merchant generators. In states where wholesale markets are vibrant, policies are needed to drive state utility commissions, the Federal Energy Regulatory Commission, and regional transmission operators (RTOs) to improve energy, capacity, and ancillary service markets so that customers, aggregators, and developers see market opportunities clearly and can respond to them.

**Resource Inclusivity.** Gas generation, renewable energy, energy efficiency, demand response, and storage each offer energy services that should be allowed to compete fairly to meet consumer and electricity system needs. And policies should recognize the ability of these resources to modify load shape (*e.g.,* using energy efficiency to reduce demand or shift it from high-demand periods), as well as to be dispatched to meet various system needs (*e.g.,* for demand response to be called upon in real-time ancillary service markets).

Modifying the load shape has value that should be recognized in long-term and day-ahead markets and competitive solicitations to meet identified net system needs. For example, the New England ISO allows energy efficiency to bid into day-ahead markets, which mitigates the net need for generation by reducing demand, reduces the need for more costly flexibility options such as pumped storage hydro or other grid-level storage, and compensates energy efficiency resources for their load reduction service.

Clean resources that demonstrate that they can be dispatched by system operators, including gas generation, demand response, storage, and renewable resources, should also be allowed to bid into hour-ahead and real-time resource markets and procurement processes. State, federal, and RTO policies that qualify low-carbon resources to provide dispatchable services should be pursued, following the example of PJM's and ERCOT's policies that allow demand response resources to bid into day-ahead, intraday, and ancillary services markets.

**"Clean First."** So far, we have emphasized making the playing field fair for clean energy resources, but policies that recognize the additional value that such resources offer relative to dirtier resources are equally important. One approach (as manifested by policies such as the California Loading Order[5]) is to apply "Clean First" principles in utility generation planning, transmission planning and operations, and electricity markets.[6, 7] Renewable energy, energy efficiency, and demand response should be procured and dispatched before dirtier resources, Fossil fuel resources thereafter should be used strategically to achieve a reliable and affordable portfolio that keeps us on the low-carbon trajectory.

In other words, the fossil fuel fleet should be optimized to complement cleaner resources. And to the extent "hybrid" technologies that combine renewable energy and co-located gas generation prove a least-cost option, they are worth considering as part of the optimized gas fleet.[8]

**We are quick to study low-carbon options, but not their relative long-term risks.**

Implementing the so-called Clean First policies in a fashion that keeps electricity supply reliable and affordable implies using natural gas strategically as part of a diversified portfolio, and implementing complementary planning, market, and regulatory reforms that together can achieve ambitious low-carbon futures at least-cost.[9, 10] Each coal plant retirement presents an opportunity. If the infrastructure is in place to support maximum

5. Staff Report, California Energy Comm'n, "Implementing California's Loading Order for Electricity Resources," July 2005, No. CEC-400-2005-043.
6. Regulatory Assistance Project. (2010). Clean First: Aligning Power Sector Regulation with Environmental and Climate Goals. Available at http://www.raponline.org/document/download/id/927.
7. California Energy Commission. (2005). Implementing California's Loading Order for Electricity Resources (CEC-400-2005-043). Available at http://www.energy.ca.gov/2005publications/CEC-400-2005-043/CEC-400-2005-043.PDF.
8. Lee, A., Zinaman, O., and Logan, J. (2012). Opportunities for Synergy between Natural Gas and Renewable Energy in the Electric and Transportation Sectors (NREL/TP-6A50-56324). Golden, CO: National Renewable Energy Laboratory and The Joint Institute for Strategic Energy Analysis.
9. Schwartz, L. et al. (2012). Meeting Renewable Energy Targets in the West at Least Cost: the Integration Challenge. Western Governors Association. Available at http://www.westgov.org/component/docman/doc_download/1610-meeting-renewable-energy-targets-in-the-west-at-least-cost-the-integration-challenge-full-report?Itemid=.
10. Regulatory Assistance Project. (2015). Power Market Operations and System Reliability in the Transition to a Low-Carbon Power System: A Contribution to the Market Design Debate. Brussels, Belgium. Available at http://www.raponline.org/document/download/id/7600.

use of energy efficiency, demand response, storage and renewable energy then making the case for smaller amounts of gas generation becomes far easier.

The implications of Clean First policies for optimizing the gas fleet should be clear: Policies should reward flexible, clean gas generation over less flexible, less clean gas, coal, and oil generation. The result will be a more efficient combination of resources and, because the resource mix is complementary, savings on investment in generation.[11]

**Improved Permitting.** Transmission, distribution, and generation investments impose environmental impacts that need to be recognized, but some of these facilities are necessary to achieve carbon reduction goals. Policies are needed to ensure that new projects are appropriately vetted and that approved projects are permitted quickly.

California's Renewable Energy Transmission Initiative – a collaborative process with environmental groups, land and wildlife advocates, utilities, electric system planners, and state, federal, and tribal officials – has been effective in getting transmission built to access the vast renewable resources in the Tehachapi region. Similar processes in the Western Interconnection (Western Renewable Energy Zone and Environmental Data Task Force) have established vetting processes to clarify where transmission line development is less damaging.

In Europe, the Renewable Grid Initiative – a collaboration between transmission system owners and leading environmental organizations – promotes acceptance of new infrastructure investments crucial to low-cost decarbonization. Effective permitting also can support the construction of well-placed gas facilities with the right operating capabilities. For example, the 692-MW Footprint Power Project in Salem, Mass., approved in September 2014, displaces generation by dirtier fossil plants and includes environmental mitigation measures that support a cleaner Salem Harbor.

All these policies – centered at the state, regional, and federal level – can support collaboration toward beneficial transmission, distribution, and generation. They continue to be necessary to ensure a "smart gas" strategy that discourages investments in unnecessary fossil generation.

Smart gas investment means recognizing the long-term costs and risks of the investment portfolio. A smart gas portfolio is a risk-aware portfolio, supported by risk-aware policies – investing in the intelligent grid and implementing policies that make system needs transparent, promote resource inclusivity, procure and dispatch clean resources first, and support effective permitting of beneficial resources.

11. IEA, 2014.